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CONCERNING THE PERFORMANCE DATA OF A REVERBERATION CHAMBER

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CONCERNING THE PERFORMANCE DATA OF A REVERBERATION CHAMBER

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I. The Data

A reverberation chamber was installed in March, 1966, in order /54** to study the vital reactions to noise and the possible preventive measures. Not many reverberation chambers of this type are in existence. Most of them are intended for investigating the sound absorption and noise insulation performance of building materials.

Our Laboratory's reverberation chamber is for biological experimentation concerning the effects of aircraft noise. It has been planned, not only for the reverberation performance, but also so that /55 living organisms can be observed and the data recorded.

The purpose of this report is to investigate the performance data of the reverberation chamber in our laboratory and its noise

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**Numbers in the margin indicate pagination in the original foreign text.

field generator in order to provide reference materials for planning future experiments.

This test research was performed between May and August, 1966.

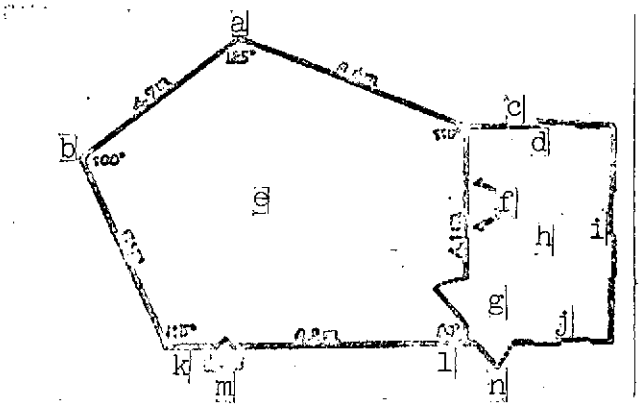


Figure 1-b. Structural data of reverberation chamber:

a — Height 6.2 m; b — Height 6.7 m; c — Height 6.7 m; d — Window; e — (Reverberation chamber); f — Observation windows; g — Reverberation chamber entrance; h — (Measuring room); i — Window; j — Window; k — Height 7.7 m; l — Height 7.7 m; m — Ventilation opening; n — Measuring room entrance

Thickness of reverberating walls: 20 cm; Ceiling inclination angle: 10°; All lengths are given in terms of inside measurements

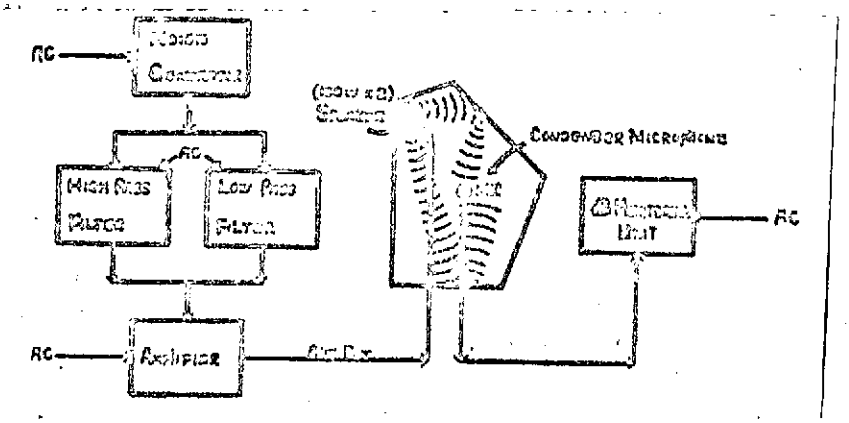


Figure 1-a. Block diagram of equipment installed in reverberation chamber:

Nomenclature: noise field generator
Standards: Nippon Sokki)S-260

II. Experimental Methods

1. An OS-260 type noise field generator manufactured by Nippon Sokki, as shown in Figure 1-a, is used as the sound source. The sound-pressure meter of the noise field generator shown in the figure, as well as an indicating noise meter (1961 model, manufactured by Rion), were used for taking the sound-pressure readings.

2. Pure tone (200 - 5,000 c/s of 100 dB in all cases) and white noise (100, 110, and 120 dB in the 200 - 10,000 c/s band) were used as the sound sources for testing. A maximum of 100 dB was used for the pure tone on account of equipment limitations.

3. The reverberation time was measured by means of a measuring amplifier (354-A) manufactured by Nippon Sokki and a high speed level recorder (301-A). The specific values of the reverberation time were found by applying a definite sound-pressure load for 30 seconds, then interrupting the load. The time after the load was interrupted until the sound field reached the noise level inside the chamber was taken as the reverberation time.

That is, since the background noise inside the chamber had a mean value of 50 dB, if, for example, the load was 100 dB, the attenuation time from 100 dB to 50 dB would be the reverberation time.

4. The sound pressure distribution inside the chamber was measured by drawing lines in radial form from the center of the room to the corners and the centers of the walls. Measurements were taken at one meter intervals along these lines.

5. Noise transmission outside the chamber was measured outside each of the walls at points in the centers of the walls. The measuring points were: immediately by the wall, 5 meters away from the wall, and 10 meters away from the wall. White noise (122 dB) was used as the sound source.

6. Further information about the structural data of the reverberation chamber is given in Figure 1-b.

III. Results

1. Maximum sound pressure and sound pressure distribution

The maximum sound pressure which could be generated in white noise was 122 dB. In the corners of the chamber and near the wall surfaces, the values were 2 - 6 dB higher. Values exceeding 130 dB were obtained directly in front of the speakers. The sound pressure distribution inside the chamber when the maximum sound pressure was applied was homogeneous, except along the wall surfaces. Figure 2 shows the results of measurements of the sound pressure distribution inside the chamber. The homogeneity of the distribution is obvious from the figure. /56

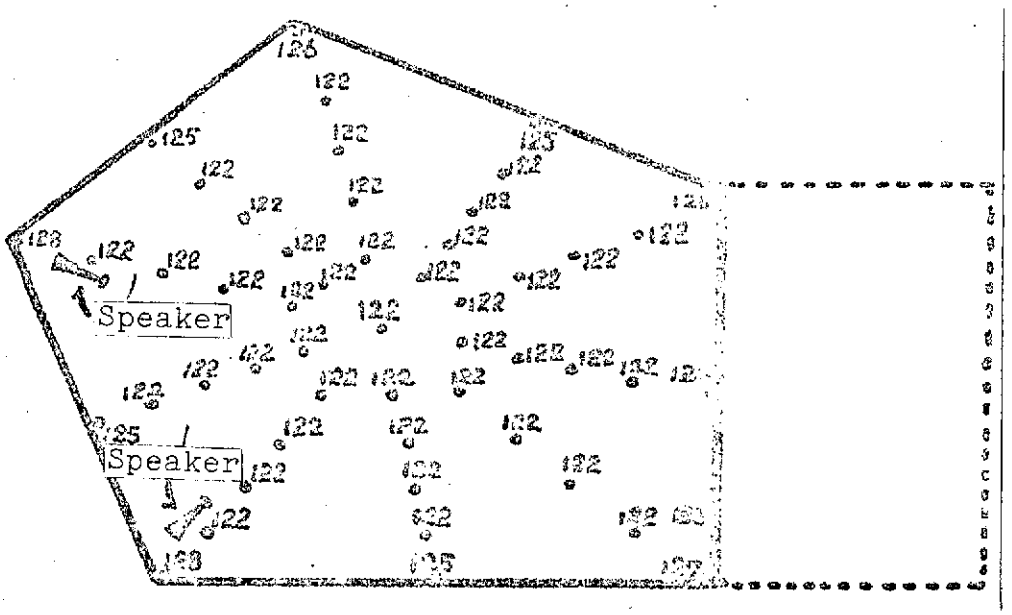


Figure 2. Sound pressure distribution inside reverberation chamber when maximum sound pressure load is applied:

Speakers — 100 W (50 W twin) × 2; sound pressure immediately in front of speakers — 130 dB or more; dots indicate measuring points; sound pressures are indicated by numbers only; the unit is dB

2. Reverberation characteristics

The reverberation times were measured for both pure tone and white noise. With pure tone of 100 dB and 200 c/s, the time was 22.6 sec. With white noise of 100 dB and 200 - 10,000 c/s, the time was 12.9 sec.

The reverberation characteristics of the pure tone and of the white noise are recorded in Figure 3-a, from which one can obtain a grasp of the attenuation patterns of the various sounds generated. The reverberation times of the pure tone for various frequencies are shown in the graph in Figure 3-b. As the frequencies become higher, the reverberation time decreases, plotting a curve in the form of a logarithmic function. For the sake of comparison, the results obtained by the firm Rion K. K. with the same type of equipment are shown in Figure 3-b by a broken line.

Typical attenuation patterns of pure tone and white noise are as shown in Figure 4. That is, while pure tone displays a wave motion as it is attenuated, white noise is attenuated more or less in a straight line.

3. Stationary properties of a sound field

Pure tone displays a wave motion, not only when it is being attenuated, but even when a constant sound pressure is maintained. It has fluctuations of ± 2 dB. In other words, a stationary sound pressure cannot be maintained with pure tone. On the other hand, almost no fluctuations occur in white noise. These circumstances /57 are shown in Figure 5.

If we perform frequency analysis of the components of the sound field produced by pure tone, as shown in Figure 6, using χ to represent the frequency used in the sound source, second and third harmonics of 2χ and 3χ will be detected. It is thought that the wave-motion phenomena occurring when pure tone is generated has something to do with this.

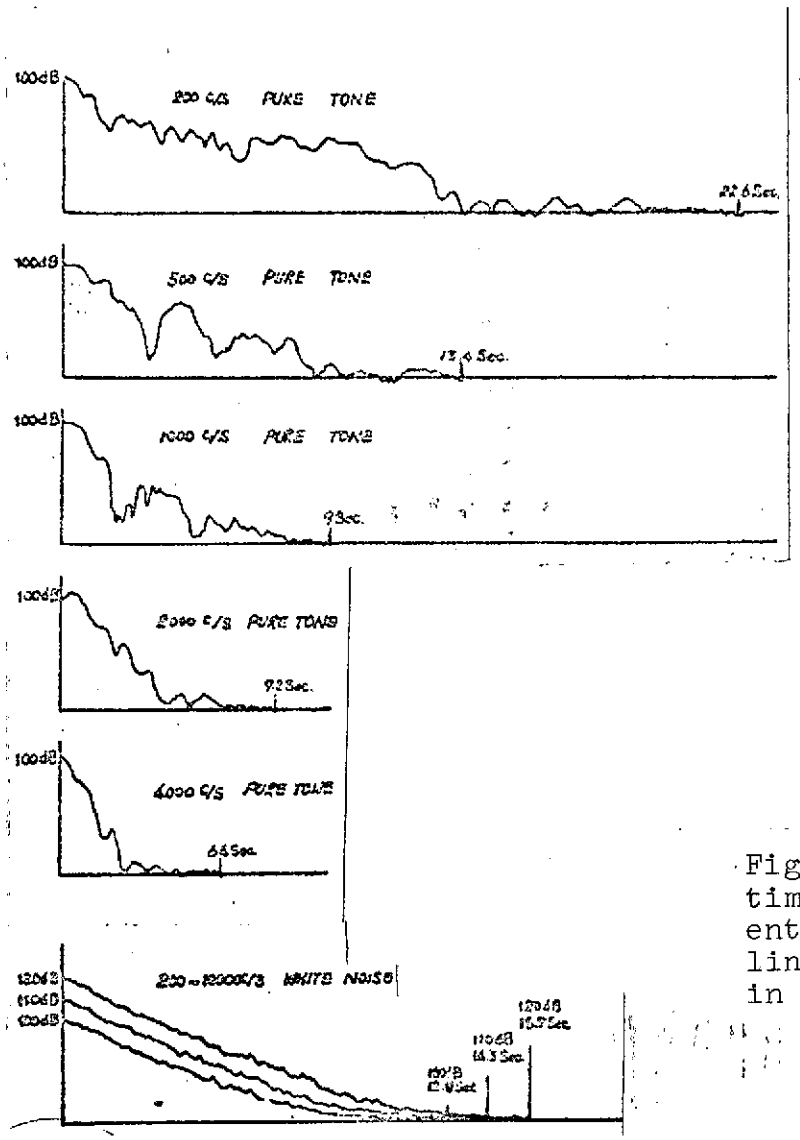


Figure 3-a. Process of attenuation of pure tone and white noise and their reverberation times

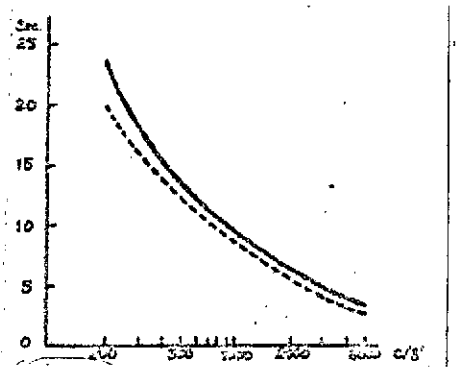


Figure 3-b. Reverberation times of pure tone for different frequencies (the broken line indicates data obtained in the reverberation chamber at Rion K.K.)

4. Precision of indication of the sound pressure indicators

In order to study the precision of indication of the sound pressure indicator (sound pressure monitoring unit) of the noise field generator, an indicating noise meter was used to make

comparative measurements for different sound pressures. The results are shown in Figure 7. Divergences of 1 - 3 dB are seen in the figure, but the indications of both instruments are more or less parallel, and the precision of indication may be said to be reliable if calibration is performed.

5. Noise transmission outside the chamber

The noise transmitted outside the chamber was measured using the maximum sound pressure (122 dB) as the sound source. These data were used to help in studying the reverberation performance. The results of these measurements are shown in Figure 8. The data in Figure 8-a were obtained when the windows of the measuring room were left open, and those in Figure 8-b were obtained when the windows were closed. It is clear from the

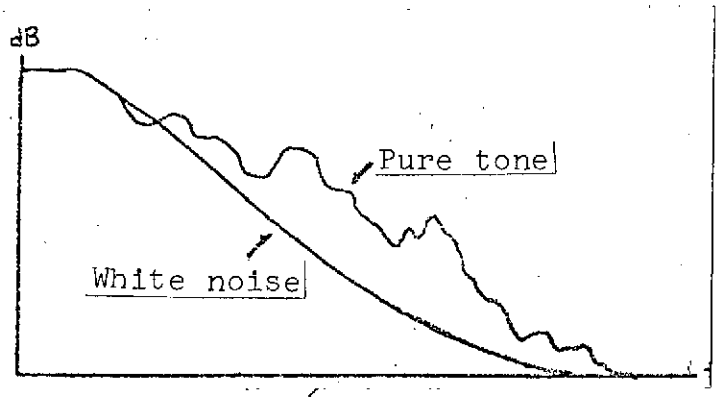


Figure 4. Comparison of the attenuation of pure tone and white noise

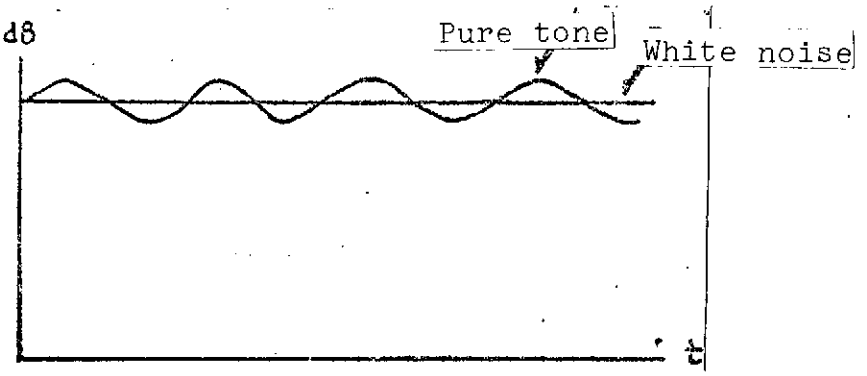


Figure 5. Comparison of temporal changes of the sound field of pure tone and white noise when the sound pressures were kept constant

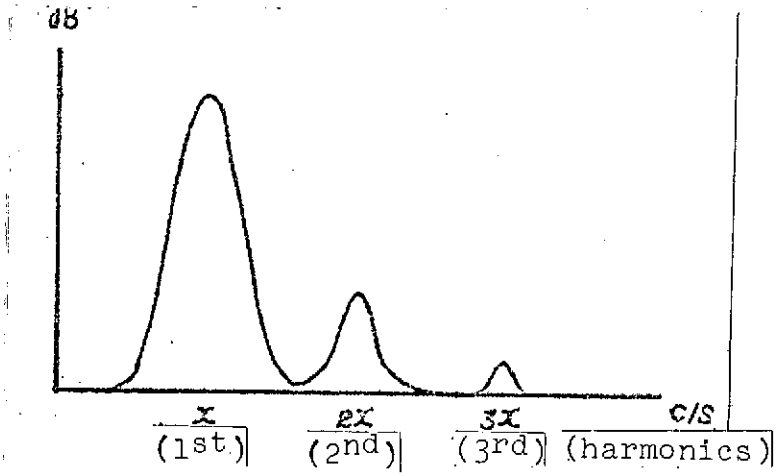
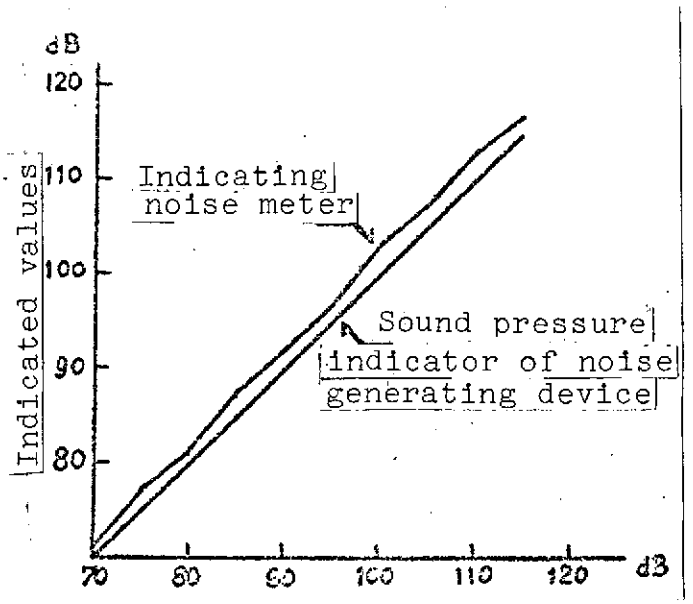


Figure 6. Frequency composition of sound field when pure tone was used as the sound source

figures that the values at a position 10 meters away from the wall surfaces become more or less the same as the background noise in the vicinity around the reverberation chamber. However, the noise transmitted to the measuring room is quite loud.

IV. Summary

Let us summarize the experimental results, including also the precautions which are necessary when actually carrying out the experiments.



Sound pressure of noise sound field

Figure 7. Comparison of indications of sound pressure indicators

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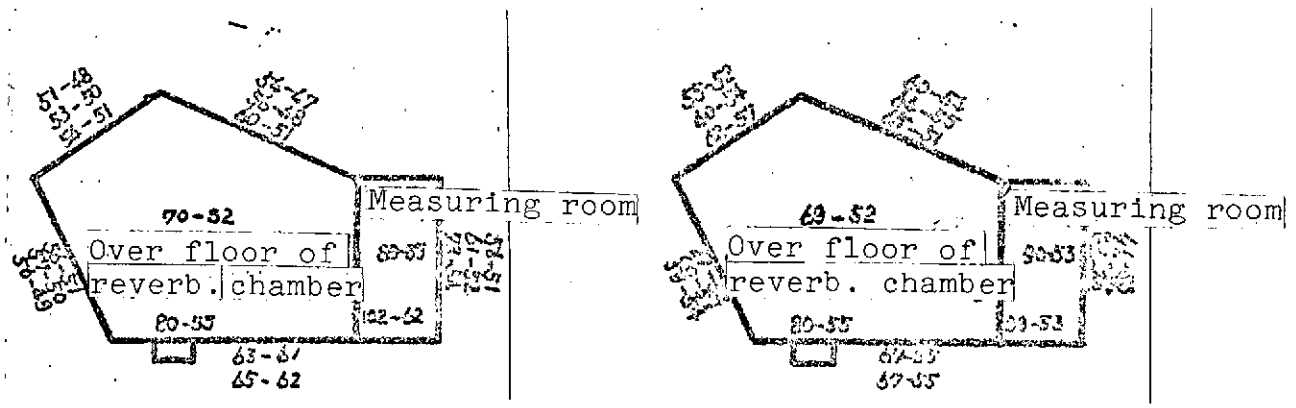

a. Windows open in measuring room

b. Windows closed in measuring room

Figure 8. Noise transmission outside the chamber (using noise of 122 dB)

The noise values are given at the measuring points. Measurements by the walls were made at points close by the walls, 5 meters from the walls, and 10 meters away from the walls

1. The maximum sound pressure using white noise is 122 dB, except in the close vicinity of the wall surfaces. The sound pressure can be maintained at a stationary level.

2. The sound field resulting from white noise is homogeneous and does not differ from place to place.

3. The reverberation time is 15.7 sec when the maximum sound pressure (122 dB) is used. (This is the time after the sound source has been shut off until attenuation to the background noise value inside the chamber.)

4. The following items may be mentioned as precautions in operation.

(1) When pure tone is used, the sound pressure of the sound field will fluctuate by $\pm$ 2 dB. Therefore, a stationary state cannot be obtained.

(2) When experiments are carried out with the sound field maintained at a level below 60 dB, the background noise tends to exert a big influence, since the average value of the background noise is 50 dB. In other words, this equipment is unsuitable for experiments aiming at a level below 60 dB.

(3) The sound pressure is not homogeneous close by the walls or immediately over the floor. Therefore, areas less than one meter away from reverberating surfaces are unsuitable as fields for experimentation.

(4) The noise field generator must be given a routine check once a year, and every effort must be made to guarantee that the equipment, in particular the generator, the filters, and the sound pressure indicator are in good working order.

5. Points for future study. /59

(1) The maximum sound pressure value obtained with white noise was 122 dB. Studies of equipment and materials will have to be made in the future, and research will be necessary in order to obtain even higher sound pressures.

(2) Since the noise transmitted through the entrance of the reverberation chamber is great (amounting to about 100 dB when there is the maximum sound pressure) and has a great influence on the measuring room, it is necessary to remodel or repair the doorway.

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16. Abstract

Description of testing results on a reverberation chamber for studying the effects of loud aircraft noise on man. The performance of the chamber and of the auxiliary equipment, consisting of a noise generator, a high- and low-pass filter, an amplifier, and a sound-level indicator, are discussed. With the noise-generating unit, a sound level of 122 dB was found in all areas in the chamber, except along the walls and in front of the speakers. A maximum reverberation time of 22.6 sec was obtained for a 200 cps pure tone (100 dB).

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